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AMENDED CLAIMS

[received by the International Bureau on 24 August 2001 (24.08.01);
original claims 1-10 replaced by new claims 1-9 (3 pages)]

1. A method of processing metal members, wherein first and second metal members are joined by

lapping at least two metal members one over the other;

pressing a planar tip of a rotor against said first metal member;

rotating said rotor and stirring the portion of said first metal member in such a direction that the rotor rotates and a direction of a thickness of the metal members to be joined by the use of friction caused by the rotating motion of said rotor while keeping the metal members in a non-molten state, so as to form a non-molten stirred layer; and

expanding the non-molten stirred layer to said second metal member,

wherein a concave portion is formed on the tip portion of said rotor.

2. The method of processing metal members according to claim 1, wherein concave and convex portions differing in height in the circumferential direction are formed on the tip portion of said rotor.

3. The method of processing metal members according to claim 1, wherein a receiving member is provided in such a manner as to face the tip portion of said rotor via

the first and second metal members and a concave portion is formed in the tip portion of said receiving member.

4. The method of processing metal members according to claim 1, wherein another rotor is provided in such a manner as to face the tip portion of said rotor via the first and second metal members, said two rotors being rotated in the opposite direction with the first and second metal members interposed between them.

5. The method of processing metal members according to claim 1, wherein the first and second metal members are continuously joined by moving said rotor.

6. The method of processing metal members according to claim 1, wherein the tip portion of said rotor is pressed from the side of one metal member of which thickness is smaller the other one.

7. The method of processing metal members according to claim 1, wherein said first and second metal members are joined by

allowing an alloy material, which can mutually diffuse with said first and second metal members, to intervene between said first and second metal members at the portion to be joined;

pressing and rotating said rotor against the portion of said first and second metal members to be

joined, and stirring the same portion by the use of friction caused by the rotating motion of said rotor while keeping the same in a non-molten state, so as to form a non-molten stirred layer; and

expanding the non-molten stirred layer to said second metal member.

8. The method of processing metal members according to claim 1, wherein said first and second metal members are joined while removing burrs produced on said first metal member in the vicinity of said rotor due to the rotating and pressing motion of said rotor.

9. A method of processing a metal member, wherein the surface of said metal members is reformed by

pressing a planar tip of a rotor against said metal member;

rotating said rotor and stirring said metal member in such a direction that the rotor rotates and a direction of a thickness of the metal members by the use of friction caused by the rotating motion of said rotor while keeping the metal members in a non-molten state,

wherein a concave portion is formed on the tip portion of said rotor.

Statement Under Article 19(1)

GB 1 385 473 A shows a process for joining between metals by a frictional process by using a rotary tool, the rotary tool having a concave portion formed on the end portion of the rotary tool. However, it does not show that the metal members are stirred by friction of the rotor contacting with the metal members in such a direction that a rotor rotates and also stirred in a direction of a thickness of the metal members while keeping the metal members in a non-molten state.

US 4 144 110 A shows a process of adhesion between plastic sheets by a frictional process by using a rotary tool, the rotary tool having a concave portion formed on the end portion of the rotary tool. However, it does not show that the metal members are stirred by friction of the rotor contacting with the metal members in such a direction that a rotor rotates and also stirred in a direction of a thickness of the metal members while keeping the metal members in a non-molten state.

DE 197 46 812 A shows a process of joining between overlapped works by a frictional process by using a rotary tool, the rotary tool having a ball or hemisphere portion formed on the end portion. However, it does not show that the metal members are stirred by friction of a rotor contacting with the metal members in such a direction that a rotor rotates and also stirred in a direction of a thickness of the metal members while keeping the metal members in a non-molten state.

DE 197 31 638 A shows a process of joining between overlapped works by a frictional process by using a rotary tool, the rotary tool having a planar portion formed on the end portion. However, it does not show that the metal members are stirred by friction of a rotor contacting with the metal members in such a direction that a rotor rotates and also stirred in a direction

of a thickness of the metal members while keeping the metal members in a non-molten state.

EP 0 893 189 A shows a friction stir welding of two adjoining thickened parts by friction produced by an insertion of an rotary tool into a joining region, the rotary tool having a small-diameter tip end formed on the end portion. However, it does not show that overlapped metal members are stirred by friction of a rotor in such a direction that a rotor rotates and also stirred in a direction of a thickness of the metal members.

The present invention achieves an advantage in that the metal members can be strongly joined without causing thermal distortion and a trace of welding by stirring the metal members by the friction of the rotor having the concave portion formed on the end portion in the direction that the rotor rotates and also in the direction of the thickness of the metal members while keeping the metal members in a non-molten state.